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ABSTRACT

This study tested whether the attitudes of 153 undergraduate women, students at Chadron State College (Nebraska), toward mathematics would predict the math-relatedness of their chosen college majors. In particular the study examined the students' confidence in learning mathematics, perceived mothers' attitudes toward the student as a learner of mathematics, perceived fathers' attitudes toward the student as a learner of mathematics, attitude toward success in mathematics, perception of mathematics as a male domain, and perceived usefulness of mathematics. All students were volunteers, 19 years or older and enrolled in general studies classes. Using six of the Fennema-Sherman mathematics Attitudes Scales intermixed into one instrument, scores were correlated with the math-relatedness of each college major listed by the participants. Math-relatedness was defined using a scale developed for the study. Multiple regression analysis revealed only one scale (usefulness of mathematics) that significantly predicted the math-relatedness of college major choice although Pearson product-moment correlations generally supported the hypothesized correlations of the attitudinal scales with math-relatedness. Appendixes contain forms and instruments from the study. (Contains 32 references.) (JB)

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Correlating Attitudes and College Majors Among Undergraduate Women

**An Abstract of a Thesis
Presented to
the Faculty of the Graduate School
Chadron State College**

**In Partial Fulfillment
of the Requirements for the Degree
Master of Arts in Education**

**by
Johnna S. Eckard**

April 1995

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Abstract

This study tested six hypotheses that college women's attitudes toward mathematics would predict the math-relatedness of chosen college majors. Using six of the Fennema-Sherman mathematics Attitudes Scales (Fennema & Sherman, 1976), the following areas were assessed: (a) confidence in learning mathematics, (b) perceived mothers' attitudes toward the student as a learner of mathematics, (c) perceived fathers' attitudes toward the student as a learner of mathematics, (d) attitude toward success in mathematics, (e) perception of mathematics as a male domain, and (f) usefulness of mathematics. These six areas were assessed with scales designed for this purpose. The six scales were intermixed into one instrument. Each scale yielded a total score for that scale. Scale scores were then correlated with the math-relatedness of each college major that was listed by the participants. Math-relatedness was defined using a scale that was developed for this study. The scale ranged from 1 (non-math related) to 4 (highly math-related). Participants were 153 undergraduate women enrolled in general studies classes at Chadron State College. All participants were volunteers and were 19 years old or older. Each participant completed the instrument. Data from the 153 instruments were analyzed using Mystat Statistical Applications (Hale, 1990) and Student Systat (Berk, 1994). Pearson product-moment correlations supported all six hypotheses ($p < .05$). However, a multiple regression analysis revealed only one scale (Usefulness of Mathematics) that significantly predicted the math-relatedness of college major choice.

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Table of Contents

	Page
List of Tables.....	iv
Chapter One: Introduction.....	2
Statement of the Problem.....	3
Delimitations.....	3
Limitations.....	4
Organization of the Remainder of the Paper.....	4
Chapter Two: Review of Related Literature.....	6
Confidence in Learning Mathematics.....	6
Attitude Toward Success in Mathematics.....	7
Usefulness of Mathematics.....	8
Mother/Father scales.....	9
Teacher scale.....	10
Effectance Motivation Scale in Mathematics.....	11
Mathematics as a Male Domain.....	12
Hypotheses.....	13
Chapter Three: Method of Procedure.....	15
Participants.....	15
Instruments.....	16
Procedure.....	20
Chapter Four: Analysis of Data.....	22
Results.....	22
Bivariate Relationships.....	24
Multivariate Relationships.....	27
Discussion.....	33

Chapter Five: Summary and Conclusion.....	40
Threats.....	40
Limitations discussed.....	40
Summary.....	46
Conclusion.....	47
Implications.....	48
Recommendations for future study.....	48
Appendices.....	50
Appendix A: Student Consent Form.....	51
Appendix B: Instructor Consent Form.....	54
Appendix C: Fennema Sherman Mathematics Attitudes	
Scales and Background Questionnaire.....	57
Background Questionnaire.....	58
Form A.....	59
Form B.....	64
References.....	69

Tables

1. Split-half Reliabilities as Calculated by Fennema and Sherman (1976).....	18
2. Class Rank Percentages.....	23
3. Mean and Standard Deviation for Math-Relatedness, Age, and Attitudinal Scales.....	25
4. Pearson Product-Moment Correlations of Math-Relatedness and Attitudinal Scales.....	26
5. Pearson Product-Moment Correlations of Age with Math-Relatedness and Attitudinal Scales.....	28
6. Pearson Product-Moment Correlations of Fennema-Sherman Scales.....	29
7. Analysis of Variance of Scores on the Attitudinal Scales by Math-Relatedness of College Major ($N = 153$).....	31
8. Results of the Multiple Regression Analysis ($N = 153$).....	32
9. Analysis of Variance of Scores on the Attitudinal Scales by Math-Relatedness of College Major ($N = 141$).....	34
10. Results of the Multiple Regression Analysis ($N = 141$).....	35

Running head: ATTITUDES AND COLLEGE MAJORS

Correlating Attitudes and College Majors Among Undergraduate Women

Johnna Eckard

Chadron State College

CHAPTER ONE

Introduction

Correlating Attitudes and College Majors Among
Undergraduate Women

Women's underrepresentation in math-related college majors correlates with unfavorable math attitudes. Research attempts to define and explain these attitudes have been diverse. For instance, Benton (1979) found that math/science majors had more positive math attitudes than non-math/science majors. Further, women in Benton's study rejected the idea of math-based, male-dominated careers. Betz and Hackett (1981) stated that college women evidenced lower mathematics self-efficacy and held traditional career beliefs. Additional findings were that mathematical interests and self-efficacy strongly predicted range of career options, where range was defined by John Holland's six themes (as cited in Betz and Hackett, 1981). Perceived career options, then, may influence college major choice. Later, Hackett (1985) stated that mathematical interests and self-efficacy predicted math relatedness of college majors. Finally, Austin-Martin, Waddell, and Kincaid (1980) analyzed, among other factors, the correlation between math attitudes and anxiety. They discovered that math anxiety had a significant relationship with women's math attitudes. Throughout the literature, the common theme is that certain correlates have been responsible for women's choice of math- or non-math-related college majors.

Statement of the Problem

Research indicates that females are inadequately represented in math-related fields of study. According to Tobias (1978), whether a college program has a math requirement often influences a woman's decision to enter a certain program. Tobias (1981, p. 17) also stated that approximately 1% of students will major in math, with women constituting only about one-third of that 1%. Since women are opting out of math-related fields of study, career opportunities are reduced by at least 50% (Fear-Fenn & Kapostasy, 1992). By and large, several attitudinal variables may be responsible for women's decisions to opt out of math-related fields.

The attitudinal variables most often cited as affecting choice of math-related college major are parental socialization, viewing math as a male domain, lack of confidence in math, poor attitudes toward success in mathematics, and difficulty perceiving math as having future usefulness. This issue of whether these attitudes affect women's college major choices at Chadron State College is addressed in this study. The results may have implications for career counselors, school counselors, and women making career decisions.

Delimitations

This study pertaining to women's attitudes toward mathematics was confined to (a) women enrolled in general studies classes at Chadron State College, and (b) women who were at least 19 years of age.

Limitations

The limitations that this study had in its detriment were: (a) the use of a hand-scored inventory, (b) the single-group, quasi-experimental design of the study, (c) the assumption that participants interpreted the inventory items as the researcher intended them to be interpreted, (d) the study's concentration on only women at Chadron State College, (e) an underdeveloped background questionnaire, (f) the lack of comprehensive literature supporting math attitudes and their relationship with college major choice, (g) the fact that the majority of students enrolled were Education majors, which was largely non-math-related, (h) the administration procedures were unable to be completely standardized, and (i) the time constraints and the lapse of time between the student's decision to participate and actual participation.

Organization of the Remainder of the Paper

Chapter Two

Research related to this study is formulated. Organization of the literature emphasizes the following scales from the Fennema-Sherman Mathematics Attitudes Scales (1976): (a) Confidence in Learning Mathematics, (b) Mother scale, (c) Father scale, (d) Attitude Toward Success in Mathematics, (e) Mathematics as a Male Domain, and (f) Mathematics Usefulness. Six hypotheses in this study were based on these Fennema-Sherman scales.

Chapter Three

The participants of the study, the instruments used, and the procedures for gathering data are explained.

Chapter Four

The results of the findings are reported. The results include bivariate and multivariate relationships. These findings are discussed in light of the six hypotheses.

Chapter Five

The final chapter evaluates the study in terms of threats to validity. The study's limitations, mentioned in Chapter One, are discussed more fully. Recommendations, implications, summary and conclusions are presented.

CHAPTER TWO

Review of the Related Literature

The focus of the literature review involved one notable study by Fennema and Sherman (1976). Their study featured the creation of scales to measure mathematics attitudes. These scales are (a) Confidence in Learning Mathematics scale, (b) Attitudes Toward Success in Mathematics scale, (c) Mathematics Usefulness scale, (d) Mother scale, (e) Father scale, (f) Teacher scale, (g) Mathematics Anxiety scale, (h) Effectance Motivation Scale in Mathematics, and (i) Mathematics as a Male Domain. The proceeding paragraphs discuss each scale.

Confidence in Learning Mathematics (C)

The first Fennema-Sherman scale is the Confidence in Learning Mathematics scale. It was developed to measure one's level of assurance to learn and perform on math activities (Fennema & Sherman, 1976).

The American Association of University Women (AAUW, 1991) found that adolescent females personalized mathematical difficulties. Corroborative studies, which stressed causal attribution theory, include Pedro, Wolleat, Fennema, and Becker (1981) and Wolleat, Pedro, Becker, and Fennema (1980). The AAUW also found that female adolescents felt inadequate for their "dream careers." Further, Pedersen, Bleyer, and Elmore (1985) offered evidence that negative changes in math confidence occur quickly during adolescence. In their study, female adolescents' math

confidence declined from seventh to eighth grade. Adolescents' dwindling math poise may eventually extend into college.

In a study by Benton (1979), college women rejected their dream careers. The continuation of faulty confidence was further demonstrated by Sax (1992). Sax reported on four-year changes of math confidence during the undergraduate college years. Then, in 1993, Sax stated that gender confidence gaps were larger for non-math/science students. In both of Sax's studies, predictors for confidence included prior mathematics confidence. Confidence, then, plays a large role in women's mathematical attempts. It is demonstrated prior to or during adolescence, and extends into adulthood.

Attitude Toward Success in Mathematics (AS)

The second Fennema-Sherman scale is the Attitude Towards Success in Mathematics scale. It was developed to assess expectations of negative or positive consequences as a result of success in math. Like confidence, this attitude is formed early, but research has provided mixed results.

The American Association of University Women (1991) suggested that adolescent females "learned" to be less competent in math and science. In essence, they learned to be unsuccessful. Pedersen et al. (1985) showed that seventh grade females' attitudes toward success in mathematics had decreased by eighth grade. By high school, young women typically attribute math success to either effort or luck, and failure to lack of ability (Pedro et al., 1981; Wolleat et al., 1980). Conversely, Thorndike-Christ (1991)

discovered that the adolescent females in her study held positive attitudes toward math success.

At the college level, Austin-Martin et al. (1980) found that less math anxious women had positive attitudes towards math success. Previously, Benton (1979) related that college women desired math success more than males. Thus, it can be argued that attitudes toward math success influence math attitudes.

Mathematics Usefulness (U)

The third Fennema-Sherman scale is the Mathematics Usefulness scale. It was designed to evaluate perceived math usefulness for education, careers, and daily life (Fennema & Sherman, 1976). Pedro et al. (1985) used this scale with high school students. They found that good mathematics usefulness attitudes had strong relationships with math plans for males and females. Additionally, adolescents who perceived mathematics as useful reported a preference for careers utilizing math (American Association of University Women, 1991). These two studies do not report gender differences, but many do.

Pedersen et al. (1985) reported that females' mathematics usefulness scores decreased from seventh to eighth grade, whereas males' scores increased. Contrariwise, Thorndike-Christ (1991) found that adolescent males and females were equally likely to perceive future usefulness in mathematics.

By college age, however, women's attitudes often shift. Austin-Martin et al. (1980) showed that less math anxious college women evidenced positive mathematics usefulness attitudes. Benton (1979) had dual findings. First, she found that students in math and

science college majors were apt to see mathematics as useful. Second, women were more likely to avoid these fields because of beliefs (i.e. usefulness) rather than fear of math. These findings suggest the need for further exploration in this area.

Mother (M) and Father (F) scale

The fourth and fifth Fennema-Sherman scales are the Mother and Father scales. They were intended to rate the students' perception of parental "interest, encouragement, and confidence in the student's ability. It also includes the student's perception of their mother's/father's example as an individual interested, confident, and aware of the importance of mathematics." (Fennema & Sherman, 1976, p. 3). Both scales are discussed in this section.

Including parental influences, Ethington (1992) conducted a study on data from the Second International Mathematics Study. This data was originally reported by Crosswhite, Dossey, Swafford, McKnight, Cooney, Downs, Grouws, and Weinzweig (as cited in Ethington, 1992). The data in Ethington's study were from eighth grade students in the United States. For females, the perception of parent's attitudes directly affected mathematics self-concept, future mathematics goals, and perceived difficulty of mathematics.

Parental attitudes may also be affected by the offspring's gender. Jacobs (1991) studied children ranging from 6th to 11th grade. She found that gender stereotyping affected mothers' and fathers' beliefs. Both had lower ability beliefs for their daughters. Further, the females had lower ability self-perceptions than males.

Parental influence is still evident at the college level. Benton (1979) found that math and science majors reported fathers as more supportive. Fathers also had higher expectations for student's success in mathematics. Fathers not only valued mathematics, but valued students as learners of mathematics. Non-math/science majors did not report these values. Parental attitudes and modeling, then, may affect college major choice.

Teacher scale (T)

The fifth Fennema-Sherman scale is the Teacher scale. It was developed to assess students' perceptions of their instructors' attitudes toward them as learners of mathematics (Fennema & Sherman, 1976). It includes interest, encouragement, and confidence in the student. Available literature supported the influence of teachers.

In their 1991 report, the American Association of University Women stated that teachers are significant in adolescents' lives. Unfortunately, females do not have as positive of interactions with teachers as males do (Fennema & Reyes, 1981). Teachers initiate more interactions with males, and males receive more feedback. This biased interaction may affect females' attitudes.

Pedersen et al. (1985) used the Fennema-Sherman Teacher scale with seventh graders. From seventh to eighth grade, females' scores decreased. Thorndike-Christ (1991) found no differences between adolescent males' and females' teacher perceptions. However, she reported that students interested in math and science perceived positive teacher attitudes.

Finally, Austin-Martin et al. (1980) reviewed correlations

between math anxiety and college women's perceptions. Their report included the Fennema-Sherman Teacher, Mother, and Father scales. The correlation between math anxiety and teacher perceptions was stronger than perceptions of either parent. Teachers, then, are influential role models; they may be of substantial value as part of intervention programs for students finding math to be problematic (Mason & Kahle, 1988).

Mathematics Anxiety (A)

The seventh Fennema-Sherman scale is the Mathematics Anxiety scale. It was created to assess anxiety associated with performing mathematics (Fennema & Sherman, 1976). This scale does not measure mathematics confidence or enjoyment of mathematics.

Betz (1977) revised the Fennema-Sherman Mathematics Anxiety scale for college students. She found that females reported higher levels of math anxiety (e.g. Betz, 1978). Kincaid and Austin-Martin (1981) showed that less anxious college women had better math attitudes. Finally, Livingston and Martray (1989) developed an abbreviated version of the Mathematics Anxiety Rating Scale (MARS). The MARS was authored by Robert M. Suinn (as cited in Livingston & Martray, 1989). The college women in Livingston and Martray's study evidenced higher levels of math anxiety than college men. Given consistent findings in the studies cited here, one may conclude that math anxious women avoid mathematics. This would, in turn, filter them from math-related college majors.

Effectance Motivation Scale in Mathematics (E)

Fennema and Sherman's eighth scale is the Effectance

Motivation scale. It was developed to measure "effectance as applied to mathematics. The dimension ranges from lack of involvement in mathematics to active enjoyment and seeking of challenge." (Fennema & Sherman, 1976, p. 5).

Pedersen et al. (1985) used that scale with seventh grade students. They found that females' scores decreased from seventh to eighth grade. Thorndike-Christ (1991) also reported that adolescent females scored lower on the Effectance Motivation Scale in Mathematics. She additionally found that effectance motivation was positively correlated with mathematics course-taking plans.

Effectance motivation is still evidenced at the college level. Bretscher, Dwinell, Heyl, and Higbee (1989) used the Effectance Motivation in Mathematics scale with college students. They found that effectance motivation was significant in predicting first quarter math grades. This early college math experience could affect future mathematics course-taking plans. Women may opt out of math-related fields as a result.

Mathematics as a Male Domain (MD)

The ninth Fennema-Sherman scale is the Mathematics as a Male Domain scale. It was designed to evaluate whether mathematics is stereotyped as a male activity. The lower the score, the more that mathematics is viewed as masculine.

This scale was used longitudinally with seventh graders by Pedersen et al. (1985). This was the only Fennema attitudinal scale in which scores did not decrease from seventh to eighth grade for females (higher scores indicated less stereotypical views).

Ethington (1992) also used this scale with junior high students from the Second International Mathematics Study. The original compilation of the data was reported by Crosswhite et al. (as cited in Ethington, 1992). Ethington's data pertained only to eighth grade students in the United States. Stereotyping math as a male domain correlated with females' perceived difficulty of math.

Beliefs in math as a male domain can still be found at the college level. Betz and Hackett (1981) sought how self-efficacy expectations affected perceived career options in college students. Females indicated that they were more likely to consider traditional female careers as defined by John Holland's six vocational themes (cited in Betz and Hackett, 1981).

Hypotheses

Each of the nine attitudes discussed above carries the likelihood of affecting college major choice. According to Tobias (1978), a woman's decision to join a program is often prejudiced by mathematics requirements. Women seldom choose majors containing math (LeFevre, Kulak, & Heymans, 1992).

This thesis probed the question of women's mathematics avoidance. The correlations between undergraduate women's mathematics attitudes and college major were investigated. It was hypothesized that women in math or math-related fields would have better mathematics attitudes than women in non-math-related fields. Based on the Fennema-Sherman Mathematics Attitudes Scales (Fennema & Sherman, 1976), the following hypotheses were derived:

1. Mathematical self-confidence will positively correlate with

choice of a math-related major,

2. Attitude toward success in math will positively correlate with choice of a math-related major,

3. Attitude toward the future usefulness of math will positively correlate with choice of a math-related major,

4. The student's perception of her father's attitude toward her as a learner of mathematics will positively correlate with choice of a math-related major,

5. The student's perception of her mother's attitude toward her as a learner of mathematics will positively correlate with choice of a math-related major, and

6. The student's lack of perception of math as a male domain will positively correlate with choice of a math-related major.

Each of the hypotheses were statistically tested at the .05 alpha level. The Fennema-Sherman Mathematics Attitudes Scales was the instrument of choice because it contained several attitudinal scales in one instrument. This was preferred due to time constraints.

CHAPTER THREE

Method of Procedure

In this chapter, the method of procedure used for this study is discussed. The design is presented in the following areas: the selection of participants, the instruments used, and the procedure in data collection.

Method

Participants

Participants were 153 undergraduate women enrolled in General Studies classes at Chadron State College. All students were volunteers and were 19 years old or older. An original total of 208 women signed forms consenting to participate (see Appendix A for the consent form). Due to absences or subsequent decisions to not participate, 160 women actually completed the six Fennema-Sherman Mathematics Attitudes Scales chosen for the study (see Appendix B).

Ages of the participants ranged from 19 to 54. The average age was 22. Of the total, 14% were freshmen, 39% were sophomores, 24% were juniors, and 23% were seniors.

Students were involved in majors offered through the following departments:

- 1) Agriculture and Industrial Technology (4 students)
- 2) Art, Speech, & Theater/Language & Literature (2 students)
- 3) Business and Economics (34 students)
- 4) Human Ecology (4 students)
- 5) Education (52 students)

- 6) Justice Studies (17 students)
- 7) Pre-professional (9 students)
- 8) Psychology (5 students)
- 9) Science/Math (11 students)
- 10) Social sciences (15 students)

Instruments

The instrument used was the Fennema-Sherman Mathematics Attitudes Scales. Six of the nine scales were used: Confidence in Learning Mathematics (C), Attitude Toward Success in Mathematics (AS), Mathematics Usefulness (U), Mother scale (M), Father scale (F), and Mathematics as a Male Domain (MD).

Of the remaining three scales, the Anxiety (A) scale was eliminated because it correlated .89 with the Confidence scale (Fennema & Sherman, 1976, p. 8). The Teacher (T) scale was eliminated because not much support was found for it at the college level (e.g. Austin-Martin et al., 1980). Finally, the Effectance Motivation (E) scale was eliminated due to its general lack of empirical support, and because it was unclear to the researcher exactly what it was intended to measure.

The Fennema-Sherman Mathematics Attitudes Scales were designed to measure the degrees of math attitudes (Fennema & Sherman, 1976). Although the instrument was normed on a high school population, it has been used with college students (Austin-Martin et al., 1980; Benton, 1979; Bretscher et al., 1989; Betz, 1977; Goolsby et al., 1987; Hackett, 1985; Hackett & Betz, 1989). As with other studies, items were slightly reworded for use with college students in the

present study.

Each of the attitudinal scales measures a different construct (Fennema & Sherman, 1976). Construct validity was statistically demonstrated by Fennema and Sherman when they created the scales. The scales were intended to measure nine different constructs. Broadbooks, Elmore, Pedersen, and Bleyer (1981) further argued for construct validation using factor analysis. In their study, eight factors were produced. These "were interpreted to indicate that the scales measure eight different constructs within the domain of mathematics attitudes." (p. 556). Broadbooks et al. reported that their results supported the Fennema-Sherman model. Recall that, of the nine scales, the confidence and anxiety scales should not be used together (Fennema & Sherman, 1976). Reliability was also found with Fennema and Sherman (1976).

Fennema and Sherman (1976) demonstrated reliability by checking for internal consistency. To do this, split-half reliabilities were calculated by Fennema and Sherman (p. 14). For convenience, the reliabilities are displayed in Table 1. Further reliability can be found in Hackett and Betz (1989). They revised five of the scales for college use. The scales were statistically reliable using the Kuder-Richardson formula, which is another method of assessing internal consistency. Kuder-Richardson (KR20) values ranged from .86 to .90 (p. 265).

Each of the six scales used for this study contained twelve items. Half of the items were positively worded; half of the items were negatively worded. Scales and items were intermixed into one

Table 1

Split-Half Reliabilities as Calculated by Fennema and Sherman (1976)

Fennema-Sherman Scale	Split-Half Reliabilities
Attitude Toward Success in Mathematics	.87
Mathematics as a Male Domain	.87
Confidence in Learning Mathematics	.93
Effectance Motivation in Mathematics	.87
Usefulness of Mathematics	.88
Father scale	.91
Mother scale	.86
Teacher scale	.88
Mathematics Anxiety	.89

instrument (see Appendix B). Positively worded items were weighted on a Likert scale from 5 (Strongly Agree) to 1 (Strongly Disagree). Negatively worded items were reverse scored so that higher scores indicated positive attitudes. Scores on each scale could range from 12 to 60. There was no meaningful overall score. (Note: High scores on the Male Domain scale indicated less stereotyped views of math as a male domain.)

Background questionnaire

Included with the instrument was a brief background questionnaire (see Appendix B). Participants were asked to list their major (or intended major), age, and academic status (Freshman-Senior).

Math-nonmath scale

For statistical purposes, two 4-point scales were developed by which to define the math-relatedness of college majors. The Deans of Chadron State College's four different schools participated in developing the scales. The four schools are: (a) The School of Business and Applied Sciences, (b) The School of Education and Physical Education, (c) The School of Liberal Arts, and (d) the School of Mathematics and Science.

Each Dean was asked to rank a series of college majors on a scale of one through four. The majors were derived from the background questionnaire of the participants. The Deans were instructed that a score of one be given to those college majors that they felt were least math-related. A score of four was to be given to those college majors that were perceived to be most math-related.

Two scales were created in order to see if statistical differences would be found. The average of the values of each major was used in creating one scale. This was the mean of each set of values. The mode was also used in order to check for differences between it and the mean of each set of values. Thus, each college major was ranked according to two scores: the mean and the mode.

Procedure

The purpose of the study was explained to 12 General Studies instructors, who all agreed to sign a consent form to allow for class interruption (see Appendix C). The 12 instructors taught a total of 21 classes. Due to circumstances, 11 instructors and 18 classes were actually involved in the study.

On a day agreed upon with each instructor, the researcher entered each class during the last 15 minutes of class. Excused at this time were: (a) the men, (b) those under age 19, and (c) those who had completed the instrument once in another class. The study was explained to the remaining women. The purpose of the study was discussed, the consent form was read aloud to the women, and any questions were answered. The women made independent, voluntary choices to sign the consent forms. The consent forms were signed in duplicate. One copy was returned to the researcher, and the other was kept by each volunteer.

During the subsequent class period, the researcher re-entered the classes to administer the instrument. All instruments were administered by the researcher. Directions were read aloud, and any further questions were answered. Instruments were administered to

each class of volunteers as a group.

Two variations of the same instrument were administered (labeled A and B). The only difference between the two versions was the order of the items on each. Forms A and B were distributed to the volunteers in an alternate fashion. The purpose of this was to reduce potential influence of the participants on one another. Seventy-seven participants completed form A, and 76 completed form B.

CHAPTER FOUR

Analysis of Data

This chapter presents the results of the research. The results were obtained by analyzing data from instruments completed by the participants. Data were analyzed using Mystat Statistical Applications (Hale, 1990) and Data Analysis with Student Systat (Berk, 1994).

Results

Sample

A total of 160 instruments were completed for this study. Of that total, data from 153 were analyzed and 7 were discarded. One instrument was incomplete, five identified majors not offered at Chadron, and one identified Interdisciplinary Studies as a major. However, the undergraduate student catalog was vague in defining this major and it was thus discarded.

Data from the seven discarded instruments were analyzed to see if any components may have affected the exclusion of inventories. Two elements were considered: (a) class rank, and (b) age of participants. First, Table 2 displays the percentages of participants in each class rank for the 7 participants whose instruments were discarded versus the 153 whose instruments were utilized. Since the majority of participants were sophomores, academic status was ruled out as a factor affecting exclusion of inventories. Second, to discover if age was a factor, a *t*-test was performed. The mean age of the 153 participants was 22.20. The mean

Table 2

Class Rank Percentages

Class Rank	<u>Percentages</u>	
	Data	Discarded
	(N = 153)	(N = 7)
Freshmen	14%	14%
Sophomores	39%	71%
Juniors	24%	0%
Seniors	23%	14%

age of the remaining seven participants was 20.29. The results showed that there was no difference in the means of either sample ($t = .803$, $df = 158$, $p > .05$). This indicated that age was not a factor affecting the exclusion of inventories. It was thus determined that no distinguishing characteristics affected the exclusion of the seven instruments.

Bivariate relationships

Table 3 shows the mean and standard deviation for the math-relatedness of majors, age of participants, and six attitudinal scales. The scales that were developed using the mean and mode of math-relatedness were used in this calculation. As can be seen, the greatest difference using either of the math-relatedness scales was the standard deviation of the math-relatedness. This difference, however, was minimal. Thus, all calculations based on either of the math-relatedness scales would have been similar. Therefore, only the scale reflecting the mean was used in further calculations.

Table 4 displays the Pearson product-moment correlations between the math-relatedness of participants' major choice and total scores on the attitudinal scales. An alpha level of .05 was used for the Pearson correlations. All scales were positively correlated with math-relatedness. Interestingly, all correlates were statistically significant. The highest correlation was between math-relatedness and the Mathematics Usefulness scale ($r = .38$, $p < .05$). This indicated that perceiving mathematics as having current and future usefulness was more indicative of math-related major choice than the other attitudes as measured by the scales. The smallest correlation

Table 3

Mean and Standard Deviation for Math-Relatedness, Age, and Attitudinal Scales (N = 153)

Attitudinal Scale	Mean Scale		Mode Scale	
	M	SD	M	SD
Math	2.16	.82	1.99	1.07
Age	22.20	6.25	22.20	6.25
C	43.24	12.49	43.24	12.49
M	45.36	7.52	45.36	7.52
F	44.79	7.97	44.76	8.00
AS	50.85	6.13	50.85	6.13
MD	54.10	5.12	54.10	5.12
U	48.52	8.51	48.52	8.51

Note. Math = Math-relatedness of college major, C = Confidence in Learning Mathematics, M = Mother scale, F = Father scale, AS = Attitude Toward Success in Mathematics, MD = Mathematics as a Male Domain, U = Mathematics Usefulness.

Table 4

Pearson Product-Moment Correlations of Math-Relatedness and
Attitudinal Scales (N = 153)

Scale	r
Confidence in Learning Mathematics	.29*
Mother scale	.30*
Father scale	.21*
Attitude Towards Success in Mathematics	.22*
Mathematics as a Male Domain	.16*
Mathematics Usefulness	.38*

Note. *p < .05, one-tailed.

was between math-relatedness and the Mathematics as a Male Domain scale ($r = .16$, $p < .05$). This indicated that viewing mathematics as a male domain did not as strongly influence math-relatedness of college major choice.

Table 5 displays the Pearson correlations of age with math-relatedness and attitudinal scales. Viewing Table 5, there were negative and significant correlations between age and the Confidence in Mathematics scale ($r = -.23$, $p < .05$). This indicated that the younger women were likely to have more confidence in learning mathematics. Significant negative correlations were also found for the Mother and Father scales ($r = -.23$ and $-.17$, respectively, $p < .05$). This suggested that the younger women reported being more strongly influenced by one or both parents than the older women.

The Pearson correlations between each scale with all other scales are presented in Table 6. All pairwise comparisons were significant ($p < .05$). The highest correlation was between the Mother and Father scales ($r = .77$, $p < .05$). This indicates that the two should not be used together in further data analysis, as strong multicollinearity is suggested.

Multivariate relationships

A multiple regression was performed to see how the attitudinal scales might combine to predict math-relatedness. Since the Mother and Father scales should not be used together, the Father scale was excluded. Of the two scales, the Mother scale was retained because it correlated higher with math-relatedness than the Father scale. The resulting analysis of variance indicated that the

Table 5

Pearson Product-Moment Correlations of Age with Math-Relatedness
and Attitudinal Scales (N = 153)

Scale	r
Math-relatedness	-.12
Confidence in Learning Mathematics	-.23*
Mother scale	-.23*
Father scale	-.17*
Attitude Toward Success in Mathematics	-.10
Mathematics as a Male Domain	.03
Mathematics Usefulness	.04

Note. * $p < .05$, two-tailed.

Table 6

Pearson Product-Moment Correlations of Fennema-Sherman Scales(N = 153)

Scale	1	2	3	4	5	6
1. C	---	.58*	.50*	.40*	.38*	.52*
2. M		---	.77*	.51*	.38*	.62*
3. F			---	.38*	.28*	.49*
4. AS				---	.36*	.53*
5. MD					---	.33*
6. U						---

Note. C = Confidence in Learning Mathematics, M = Mother scale, F = Father scale, AS = Attitude Toward Success in Mathematics, MD = Mathematics as a Male Domain, U = Mathematics Usefulness

* $p < .05$, two-tailed.

regression was significant ($F = 5.549$, $df = 5, 147$, $p < .05$). Table 7 displays the analysis of variance. The corresponding prediction equation for the multiple regression was as follows: $MATH = .197 + .007C + .006M - .001AS + .001MD + .028U$. The prediction equation demonstrates how much MATH would change if each variable were to increase by one while other variables are held constant. To exemplify, if the C scale increased by one point for any given case, the corresponding math-relatedness (MATH) would increase by .007 points for that case.

The results of the multiple regression analysis are presented in Table 8. An analysis of the data in Table 8 indicated that the only significant scale was the Mathematics Usefulness scale ($t = 2.782$, $df = 5, 147$, $p < .05$). As can be seen, the resulting regression accounted for only 15.9% of the variability in the dependent variable. This may indicate that the group was fairly homogenous in how they answered the items in the instrument (Smith & Glass, 1987, p. 56). Since only one predictor was found to be significant using the multiple regression model, the reader is cautioned regarding data interpretation.

The data from the multiple regression indicated that one case was an outlier and three cases had large leverage. An outlier is a case classed away from the main group of scores because of its extreme value. Those with large leverage indicated cases with unusual scale scores. An examination of the raw data showed that the outlier case had scale scores incompatible with the value of the math-relatedness. The cases with large leverage, on the other hand,

Table 7

Analysis of Variance of Scores of the Attitudinal Scales by
Math-Relatedness of College Major (N = 153)

Source of Variation	df	Sum of Squares	Mean Squares	F
Between Groups	5	16.068	3.214	5.549*
Within Groups	147	85.134	.579	
Total	152	101.202		

Note. *p < .05.

Table 8

Results of the Multiple Regression Analysis (N = 153)

Scale	B	t	df	R	R ²
Total Model			5, 147	.398	.159
Confidence in Learning	.109	1.113			
Mathematics					
Mother scale	.057	.526			
Attitude Toward Success	-.007	-.073			
in Mathematics					
Mathematics as a Male Domain	.009	.107			
Mathematics Usefulness	.289	2.782*			

Note. *p < .05.

had inconsistent scale scores. To observe the affect of these cases on the data analysis, the outlier and large leverage cases were omitted from the data until no further warnings from the Student Systat multiple regression program (Berk, 1994, p. 250) were presented. A multiple regression analysis was run a second time on the resulting data set. The corresponding prediction equation was as follows: $\text{Math} = .456 + .009C + .011H - .001AS - .007MD + .025 U$. Table 9 displays the analysis of variance, and Table 10 shows the results of the multiple regression.

Viewing Table 9, the regression is still significant ($F = 4.818$, $df = 5, 135$, $p < .05$), although 12 cases had been deleted from analysis, leaving 141. In viewing Table 10, the only attitudinal scale to reach statistical significance was again the Mathematics Usefulness scale ($t = 2.178$, $df = 5, 135$, $p < .05$). Neither the outlier nor the large leverage cases, then, differentially affected the multiple regression.

Discussion

The results of the Pearson product-moment correlations generally support the hypothesized correlations of the attitudinal scales with math-relatedness. Only one hypothesis is supported using the multiple regression model, however. Each hypothesis is restated and discussed in the proceeding paragraphs.

Hypotheses

1. Mathematical self-confidence will positively correlate with choice of a math-related major.

This hypothesis is supported using the Pearson product-moment

Table 9

Analysis of Variance of Scores of the Attitudinal Scales by
Math-Relatedness of College Major (N = 141)

Source of Variation	df	Sum of Squares	Mean Squares	F
Between Groups	5	13.622	2.724	4.818*
Within Groups	135	76.337	.565	
Total	140	89.959		

Note. * $p < .05$.

Table 10

Results of the Multiple Regression Analysis (N = 141)

Scale	B	t	df	R	R ²
Total Modal			5, 135	.389	.151
Confidence in Learning	.135	1.295			
Mathematics					
Mother scale	.100	.870			
Attitude Toward Success	-.009	-.083			
in Mathematics					
Mathematics as a Male Domain	-.036	-.385			
Mathematics Usefulness	.241	2.178*			

Note. *p < .05.

correlation ($r = .29, p < .05$). This is in-line with Hackett (1985) if confidence can be interpreted as mathematics self-efficacy. In Hackett's study, self-efficacy correlated highly with major choice for both women and men. Further, Hackett and Betz (1989) found that math self-efficacy strongly predicted math-related major choice. However, they offered the warning that Fennema and Sherman's (1976) Confidence scale assesses a more generalized attitude. Finally, Thorndike-Christ (1991) offers support for adolescent students interested in mathematics as having high confidence levels. Confidence is also found to be significantly correlated with math course-taking plans ($p < .0001$) in Thorndike-Christ's study. Both, in turn, can affect college major choice.

2. Attitude toward success in math will positively correlate with choice of a math-related major.

This hypothesis is also supported with the Pearson correlation ($r = .22, p < .05$). Similar support is found in Thorndike-Christ's (1991) study, wherein higher scores are reported for females on the Attitude Toward Success in Mathematics scale. These positive attitudes significantly correlate with math course-taking plans in Thorndike-Christ's study.

3. Attitude toward the future usefulness of math will positively correlate with choice of a math-related major.

A significant Pearson correlation supports this hypothesis ($r = .38, p < .05$). Several other studies report using the Mathematics Usefulness scale, with positive but varying results. For instance, Benton (1979) reports results of the Usefulness of

Mathematics scale in his study of undergraduates. In Benton's study, math and science majors were more likely to view math as useful. Pedro et al. (1981) also used this Fennema-Sherman scale. Performing a stepwise multiple regression on their data with mathematics achievement as the dependent variable, they state that viewing math as useful was the strongest variable for females ($F = 50.74, p < .01$). This is similar to the first multiple regression finding in the present study ($F = 5.549, df = 5, 147, p = .05$), where the Mathematics Usefulness scale was the only significant scale.

4. The student's perception of her father's attitude toward her as a learner of mathematics will positively correlate with choice of a math-related major.

The Pearson product-moment correlation supports this hypothesis ($r = .21, p < .05$). Other studies that utilize the same Fennema-Sherman scale demonstrate support for it. For instance, Benton (1979) states that math and science majors report fathers as being both supportive and having high expectations for the student's success in math. A second study is Thorndike-Christ's (1991) study. She reports that the Father scale correlated positively with math course-taking plans ($r = .29, p < .0001$). These findings do not directly support the results in the present study, but they do suggest a trend of positive attitudes and selection of mathematics.

5. The student's perception of her mother's attitude toward her as a learner of mathematics will positively correlate with choice of a math-related major.

This hypothesis also receives support through the Pearson

correlation ($r = .30, p < .05$). One significant study using the Fennema-Sherman Mother scale is Thorndike-Christ (1991). She reports that students interested in mathematics and physical sciences had high scores on the Mother scale. Additionally, the Mother scale correlated positively with math course-taking plans. Like the supporting literature for the Father scale, these findings do not directly support the results in the present study, but again a positive trend is indicated.

6. The student's lack of perception of math as a male domain will positively correlate with choice of a math-related major.

This is the final hypothesis introduced in this study. While the results for this hypothesis reached statistical significance in the present study ($r = .16, p < .05$), it was not a high correlation. Studies that report using the Mathematics as a Male Domain scale are Benton (1979) and Thorndike-Christ (1991). Benton's report states that math and science majors were less likely to stereotype math as male domain. In Thorndike-Christ's study, females had more positive Mathematics as a Male Domain scale scores than males. This significantly correlated with math course-taking plans.

In concluding statements regarding the hypotheses, all were statistically significant. The literature generally supports these findings.

It may be interesting to note that, in the present study, older students were more likely to stereotype math as male domain. This indicates that they are less likely to enter a math-related field. This result is supported by LeFevre et al. (1992). These

researchers also found that older females were less apt to enter math-related fields. The mean age of the undergraduate females in the LeFevre et al. study was 21.7. In the present study, the mean age was 22.20. Age ranges in the LeFevre et al. study are unknown. The ages of the women in the present study ranged from 19 to 54.

CHAPTER FIVE

Summary and Conclusions

This chapter presents threats to the study, a summary of the problem investigated, the procedures used, and the data obtained. Included in this section are implications of the study and recommendations for future study.

Threats

Threats to the validity of this study are both internal and external. The proceeding paragraphs discuss probable threats, beginning with internal validity.

Internal validity

First, there is a certain, undocumented amount of what Smith and Glass (1987) refer to as attrition or mortality. The subjects who completed the study may have had characteristics different from those who did not participate or who withdrew. While it is also known that many students were present in several classes and thus could not retake the inventory, the attrition rate nevertheless affects results. This presents a related threat, which is a sample size that may be too small.

A second threat to internal validity is that the dependent variable was poorly measured (Smith & Glass, 1987). It is more appropriate to use a validated continuum or scale of the math-relatedness of college majors. This ensures that a higher level on a continuum or scale would indeed indicate more math-relatedness. The problem with either scale used in this study is that both

represent a more subjective approach to creating a continuum. Math-relatedness of majors was ranked by the Deans of Chadron State College's four Schools. It is noted that some majors were ranked quite low in math-relatedness by some Deans, while the same majors were ranked highly by other Deans. This incongruence may affect the results.

A final threat to the internal validity of this study is called treatment diffusion (Smith & Glass, 1987). This refers to the fact that important information may have been communicated to those who had not yet taken the inventory. Thus, some of the participants who had not taken the inventory may have been persuaded to drop out (attrition), or to answer a certain way, which may skew the results.

External validity

Threats to this study's external validity can be divided into two groups: a) threats to population external validity, and b) threats to external validity of operations (Smith & Glass, 1987).

First, as a threat to population external validity, the sample in this study may not be representative of students outside of the enrollment of Chadron State College's student body. Smith and Glass (1987) refer to this as noncomparability. The majority of participants in this study are education majors, which was primarily low in math-relatedness. The low Pearson correlations may reflect the small number of women actually enrolled in math-related majors.

Second, Smith and Glass (1987) refer to experimenter effects and task effects. Both are threats to external validity of operations. Experimenter effects refer to how the experimenter or

researcher may influence the task of the subjects. Subjects may be encouraged, discouraged, or perceive expectations about how they should perform. While the same set of directions and explanations were read to all subjects in the present study, class sizes ranged from 5 to over 30 participants. Interactions between researcher and participants may have been more formal with larger groups. Also, the presence of, and comments by, class instructors may have influenced participation. Task effects, on the other hand, refer to any number of objects or perceptions regarding the task, which can affect outcome. Examples are the content, diction, length, appeal of syntax, and overall structure of the instrument used.

Other threats

While the above paragraphs address threats to internal and external validity, one other factor may also have affected the results: the women in this study were given only the last 15 minutes of class to complete the instrument. While the amount of time was sufficient, the women overall seemed anxious to leave class with their classmates who had been excused. It is the researcher's opinion that the instruments were completed hastily, without much thought given to items on the instrument. This is especially evident with the large leverage cases, which are discussed in the Results section. The outcome of such hasty completion is scale scores that do not appropriately correlate with math-relatedness of the college majors.

Limitations

This study had in its detriment several limitations. Some of these limitations are also threats, as will be seen in the following paragraphs.

One significant limitation in the present study concerned the wording of one item in the Mathematics as a Male Domain scale. Of 153 cases, 25% disagreed or strongly disagreed when responding to the statement that "Males are not naturally better than females in mathematics." Interestingly, on all 11 other items in that scale, the respondents answered in an expected direction. In other words, of 12 items, only one was consistently answered opposite the others in the scale of 25% of the participants. In reviewing the statements preceding that item, there appeared to be no indication that previous statements influenced the answer. The researcher feels that the item was misread as "Males are naturally better than females in mathematics." As quickly as most respondents read the items, it would have been an easy mistake.

A second limitation concerns the design. This was a single-group, quasi-experimental correlational design. It is quasi-experimental because the volunteers were not randomly selected. This may result in a biased sample. Since the participants were volunteers, this self-selection may also have produced a biased sample.

Third, while most studies in the literature compared females and males, this study concentrated only on females. This limited the study as one cannot see how males of similar ages and with similar

college major choices compared. This could have proved interesting in light of the results of the Mathematics as a Male Domain scale correlations. Since Chadron State College is in a rural area, and is primarily known for teacher education, it may be valuable to assess if males and females followed similar attitudinal patterns.

A fourth limitation lies with the background questionnaire. As there were time constraints, the background questionnaire is not as fully developed as it should have been. It lacks important information that may have provided clues as to why certain trends occurred with the attitudinal scales.

A fifth limitation concerns the lack of comprehensive literature supporting math attitudes and their relationship with math-relatedness of college majors. Most available studies investigated the effect of math anxiety on other attitudes and variables. This study, excluding math anxiety, is limited in this way. Many studies also do not focus on college participants; the interest generally appears to be the math attitudes of grade school, middle school, and high school students.

A sixth limitation may have been the inappropriateness of the study given the math-relatedness of a majority of majors. Since a majority of volunteers were education majors, which was also mostly non-math-related, the sample drawn is not necessarily representative of the typical college student.

A seventh limitation concerns the math-relatedness scale. A scale defining math-relatedness was created, as a validated one was not found. The lack of validation is not the only weakness, however.

The method of creating the scale seems to be a highly subjective approach. There remains a question of what college majors are actually considered math-related, and in what way.

An eighth limitation is the lack of standardization of the administration procedure. While opening explanations, requests, and directions were the same for each class, there were differences among instructors in how events precipitated. This appeared to influence decisions to participate, and may also have influenced how volunteers answered scale items. For example, some instructors remained present while the researcher explained the study and sought volunteers. It is felt that the instructor's presence (and, sometimes, comments) may have persuaded or possibly dissuaded participation. Also, there were occasions when classes were away from the classroom when the instrument was to be administered. The volunteers from those classes had to leave one site and return to the classroom to participate. This not only resulted in attrition that otherwise may have been lacking, but often shortened the time allotted. Further, some instructors did not end class at the agreed upon time, which caused participants to rush to complete the instrument.

A final limitation is the time constraints imposed on the students completing the instrument, as well as the lapse of time between the decision to participate and actual participation. First, at least two days, but no more than four, lapsed between decisions to participate and actual participation. This may have allowed students time to contact others who may have participated in the

study. Thus, results could have been skewed in a direction otherwise not a concern. Finally, while 15 minutes was more than enough time to complete the instrument, the participants appeared to want to rush. As speculated earlier, the participants appeared to want to leave with their friends and classmates who were excused early. It would be preferable to administer the instrument to an entire class, and begin the assessment at the start of class.

Summary

The purpose of this study was to investigate whether college women's attitudes toward mathematics predicted their choice of math-related or non-math-related majors. The women participating in this study were enrolled in General Studies classes at Chadron State College and were 19 years old or older.

In particular, this study involved cooperation from female volunteers to complete an instrument, which was comprised of six of the Fennema-Sherman Mathematics Attitudes Scales. Consent forms were signed by all volunteers. Although there were 160 volunteers, data from 153 were actually analyzed. This is only a 4% attrition rate. Observation of the percentages of women in the different class ranks, and a t -test run on the ages of participants, indicated that no distinguishing characteristics affected the exclusion of the seven instruments.

Using the data obtained from the instruments, the mean, standard deviation, and Pearson product-moment correlations were produced using the Mxstat Statistical Package (Hale, 1990). The t -test, analysis of variance, and multiple regression equation were

run using Student Systat (Berk, 1994).

An analysis of the data indicated that all six of the attitudinal scales correlated significantly with math-relatedness of college major. Of these six scales, the Usefulness of Mathematics scale correlated the highest with math-relatedness of college major. This was also the only scale found to be significant in the multiple regression equation.

Conclusion

An observation of only the scale scores of the 153 women indicated a trend of fairly positive attitudes toward mathematics. Scale scores could range from 12 to 60. With the Confidence in Mathematics scale, the majority of scores were in the 50s range. The Attitude Toward Success in Mathematics showed the majority of scores to be in the upper 40s, but several scores were also in the upper 50s range. The Mathematics Usefulness scale had the majority of its scorers equally divided between the lower 50s and the upper 50s. The most frequently occurring score of the Mathematics as a Male Domain scale was 60. (Recall that higher scores indicate less stereotypical views of mathematics.) The Mother and Father scales were the least supported of the scales. Scores occurred mostly in the range of 42 and 43 for the Mother scale; scores occurred mostly in the range of 38 and 39 for the Father scale.

These results indicate that while parents may not be heavily influential, positive attitudes have been developed among this sample. If these figures can be generalized, then better attitudes may result in women choosing math-related careers more often. This

will reduce the demand for women in math-related fields. Again, the majority of respondents in this sample were education majors, which is fairly non-math related. It should be kept in mind, however, that Chadron State College's reputation is built on its Education Department. This study's sample of college majors versus mathematics attitudes may not be representative of the general population.

Implications

The results of this study, as with studies similar to it, have implications for career counselors, instructors, parents, and students. Career counselors need to become aware of female students' attitudes towards mathematics as they assist in the guidance of college major and career choice. Similarly, women need to be aware of their attitudes toward mathematics and how such attitudes shape college and career decisions. Instructors can help women develop positive attitudes toward mathematics by modeling positive attitudes, and by demonstrating the future usefulness of mathematics. Finally, parents should become cognizant of their covert and overt messages regarding mathematics to their daughters. These messages include mathematics in general and perception of oneself in relation to mathematics.

Recommendations for future study

No attempt was made in this study to include males of similar age and background. Thus, there was no indication of whether the women in this study differed markedly from the general student population enrolled at Chadron State College. Men were assumed to more likely be enrolled in math-related fields, but this was not

tested. Further, no attempt was made to determine background characteristics or cultural make-up of the women. Thus, any of several characteristics could be responsible for major choice in addition to, or instead of, mathematics attitudes. Finally, no attempt was made to interview the respondents, which would have provided insight as to the nature of responses and how attitudes developed.

Appendices

Appendix A
Student Consent Form

Appendix A

October/November 1994

To: Participants

From: Johnna Eckard

RE: Consent form

You are invited to participate in a study of college women and their attitudes regarding mathematics.

You are selected as a possible participant in this study because you are enrolled in a general studies class, which should allow for a cross-representation of college majors, and you are at least 19 years of age.

If you decide to participate, I will request your cooperation in the completion of the Fennema-Sherman Mathematics Attitudes Scales. This instrument should reasonably be completed in 15 minutes. Included with the instrument is a brief background questionnaire. Your only inconvenience will be the time it will take you to fill out the necessary information.

No information in connection with this study will be identified with you. In any written reports or publications only aggregate data will be presented; no one will be identified by name or will be identifiable by variable.

Your decision whether or not to participate will not affect your current or future relations with Chadron State college in any way. If you decide to participate, you are free to discontinue participation at any time prior to the completion of the items. After completion, you will be unidentifiable.

If you have any questions about the research and/or research subjects' rights, please call Johnna Eckard at 432-7643.

You will be offered a copy of this form to keep.

You are making a decision whether or not to participate. Your signature indicates that you have read the information provided above, are at least 19 years old, and have decided to participate. Should you choose to discontinue participation in this study, you may withdraw prior to completion without prejudice even after signing this form.

Signature

Date

Signature of Student Researcher

Date

Appendix B
Instructor Consent Form

Appendix B

September 1994

To: Chadron State College Instructors

From: Johnna Eckard, Graduate Student

RE: Graduate Degree Thesis

The purpose of this document is to obtain written permission to enter one or more of your classes for the purpose of gathering volunteers for a thesis project and administering a subjective instrument. The thesis will concern itself with what possible variables could predict a female student's decision to enter a math-related or non-math-related field of study.

At an agreed upon date, I will need the last fifteen minutes of your class period(s) to obtain female volunteers and administer background questionnaires/mathematics attitudes instruments to the volunteers as a group. I will obtain volunteers' written consent at the end of one class period, and return at the end of a second to administer the questionnaire/instrument.

The instrument is the Fennema-Sherman Mathematics Attitudes Scales. Six of the nine scales will be used, and are as follows: Confidence in Learning Mathematics, Mother scale, Father scale, Attitude Toward Success in Mathematics, Mathematics as a Male Domain, and Usefulness of Mathematics. All are self-explanatory by title except the Mother/Father scales. These measure the student's perception her mother's/father's attitude toward her as a learner of mathematics.

Within each scale there are twelve items, six of which are positively worded and six of which are negatively worded. To check for internal consistency, split-half reliabilities were calculated by the producers of the instrument. The reliabilites are as follows: Attitude Toward Success in Mathematics = .87, Mathematics as a Male Domain = .87, Confidence in Learning Mathematics = .93, Usefulness of Mathematics = .88, Mother scale = .86, and Father scale = .91. This is the extent to which part scores are experimentally independent (errors on one part should not be linked to errors on another). The validity of the instrument is demonstrated in numerous studies having used the Fennema-Sherman Mathematics Attitudes Scales.

In a previous discussion with you, I have obtained your verbal permission to enter your class(es). Your signature below verifies your agreement and cooperation.

Thank you for allowing me some of your class time for the purpose of gathering information for my thesis.

Instructor's Signature

Date

Student Researcher

Date

Appendix C

Fennema-Sherman Mathematics Attitudes Scales
and Background Questionnaire
Forms A and B

Appendix C

FORMS A AND B

Directions:

On the following pages is a series of statements. There are no right or wrong answers for these statements. They have been set up in a way which permits you to indicate the extent to which you agree or disagree with each statement expressed.

As you read each statement, you will know whether you agree, disagree, or are uncertain how you feel. If you strongly agree, circle SA. If you agree but with reservations, circle A. If you neither agree or disagree, this is, you are not certain, circle U. If you cannot answer a question, also circle U. If you disagree with the statement, circle D. If you strongly disagree, circle SD.

Please do not spend much time with any statement, but be sure to answer every statement. Work quickly but carefully. Some of the items will seem similar to others, but they are different, so do answer all items.

There are no right or wrong answers. Your answer is simply what is true for you. Whenever possible, let the things that have happened to you in the past help you make a choice.

When you have completed the instrument, please return it to me. You are then free to leave unless your instructor has specified otherwise.

THIS INVENTORY IS BEING USED FOR RESEARCH PURPOSES ONLY AND NO ONE WILL EVALUATE OR EVEN KNOW WHAT YOUR INDIVIDUAL RESPONSES ARE.

Please complete the following information before turning the page:

College major: (Education majors please include endorsements)

(If you are undecided, list what you think you would be interested in or what you plan to major in).

Age _____

Academic Status: Freshman Sophomore Junior Senior
(Circle one)

FORM A

	SA	A	U	D	SD
	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. Mathematics is a worthwhile and necessary subject.	SA	A	U	D	SD
2. My father thinks I need to know just a minimum amount of math.	SA	A	U	D	SD
3. Males are not naturally better than females in mathematics.	SA	A	U	D	SD
4. Math has been my worst subject.	SA	A	U	D	SD
5. My mother has always been interested in my progress in mathematics.	SA	A	U	D	SD
6. If I got the highest grade in math I'd prefer no one knew.	SA	A	U	D	SD
7. I'll need a firm mastery of mathematics for my future work.	SA	A	U	D	SD
8. My father has shown no interest in whether or not I take more math courses.	SA	A	U	D	SD
9. Women certainly are logical enough to do well in mathematics.	SA	A	U	D	SD
10. Most subjects I can handle O.K., but I have a knack for flubbing up math.	SA	A	U	D	SD
11. My mother has strongly encouraged me to do well in mathematics.	SA	A	U	D	SD
12. I would make people like me less if I were a really good math student.	SA	A	U	D	SD
13. Knowing mathematics will help me earn a living.	SA	A	U	D	SD
14. As long as I have passed, my father hasn't cared how I have done in math.	SA	A	U	D	SD
15. I think I could handle more difficult mathematics.	SA	A	U	D	SD

	SA	A	U	D	SD
	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
16. My mother thinks I need to know just a minimum amount of math.	SA	A	U	D	SD
17. I'd be proud to be the outstanding student in math.	SA	A	U	D	SD
18. Mathematics is for men; arithmetic is for women.	SA	A	U	D	SD
19. My father thinks that mathematics is one of the most important subjects I have studied.	SA	A	U	D	SD
20. I expect to have little use for mathematics when I get out of school.	SA	A	U	D	SD
21. I am sure that I can learn mathematics.	SA	A	U	D	SD
22. My mother wouldn't encourage me to plan a career which involves math.	SA	A	U	D	SD
23. It would be really great to win a prize in mathematics.	SA	A	U	D	SD
24. I would expect a woman mathematician to be a masculine type of person.	SA	A	U	D	SD
25. My father thinks I could be good in math.	SA	A	U	D	SD
26. In terms of my adult life it is not important for me to do well in mathematics in college.	SA	A	U	D	SD
27. I am sure I could do advanced work in mathematics.	SA	A	U	D	SD
28. My mother has shown no interest in whether or not I take more math courses.	SA	A	U	D	SD
29. Being first in a mathematics competition would make me pleased.	SA	A	U	D	SD

	SA	A	U	D	SD
	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
30. Girls who enjoy studying math are a bit peculiar.	SA	A	U	D	SD
31. My father has always been interested in my progress in mathematics.	SA	A	U	D	SD
32. Taking mathematics is a waste of time.	SA	A	U	D	SD
33. I have a lot of self-confidence when it comes to math.	SA	A	U	D	SD
34. My mother hates to do math.	SA	A	U	D	SD
35. Girls can do just as well as boys in mathematics.	SA	A	U	D	SD
36. My father thinks advanced math is a waste of time for me.	SA	A	U	D	SD
37. I would trust a woman just as much as I would trust a man to figure out important calculations.	SA	A	U	D	SD
38. For some reason even though I study, math seems unusually hard for me.	SA	A	U	D	SD
39. My mother thinks that mathematics is one of the most important subjects I have studied.	SA	A	U	D	SD
40. I don't like people to think I'm smart in math.	SA	A	U	D	SD
41. I'll need mathematics for my future work.	SA	A	U	D	SD
42. If I had good grades in math, I would try to hide it.	SA	A	U	D	SD
43. My mother thinks I'll need mathematics for I want to do after I graduate from college.	SA	A	U	D	SD

	SA	A	U	D	SD
	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
44. I'm not the type to do well in math.	SA	A	U	D	SD
45. My father thinks I'm the kind of person who could do well in mathematics.	SA	A	U	D	SD
46. I can get good grades in mathematics.	SA	A	U	D	SD
47. As long as I have passed, my mother hasn't cared how I have done in math.	SA	A	U	D	SD
48. Studying mathematics is just as appropriate for women as for men.	SA	A	U	D	SD
49. I would have more faith in the answer for math problem solved by a man than a woman.	SA	A	U	D	SD
50. Being regarded as smart in mathematics would be a great thing.	SA	A	U	D	SD
51. Mathematics will not be important to me in my life's work.	SA	A	U	D	SD
52. My father thinks I'll need mathematics for what I want to do after I graduate from college.	SA	A	U	D	SD
53. People would think I was some kind of a grind if I got A's in math.	SA	A	U	D	SD
54. Females are as good as males in geometry.	SA	A	U	D	SD
55. It's hard to believe a female could be a genius in mathematics.	SA	A	U	D	SD
56. My mother thinks I could be good in math.	SA	A	U	D	SD
57. I don't think I could do advanced mathematics.	SA	A	U	D	SD

	SA	A	U	D	SD
	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
58. I will use mathematics in many ways as an adult.	SA	A	U	D	SD
59. My father wouldn't encourage me to plan a career which involves math.	SA	A	U	D	SD
60. I study mathematics because I know how useful it is.	SA	A	U	D	SD
61. I'm no good in math.	SA	A	U	D	SD
62. My mother thinks I'm the kind of person who would do well in mathematics.	SA	A	U	D	SD
63. When a woman has to solve a math problem, it is feminine to ask a man for help.	SA	A	U	D	SD
64. I'd be happy to get top grades in mathematics.	SA	A	U	D	SD
65. My father hates to do math.	SA	A	U	D	SD
66. It would make me happy to be recognized as an excellent student in mathematics.	SA	A	U	D	SD
67. My mother thinks advanced math is a waste of time for me.	SA	A	U	D	SD
68. Generally I have felt secure about attempting mathematics.	SA	A	U	D	SD
69. Mathematics is of no relevance to my life.	SA	A	U	D	SD
70. My father has strongly encouraged me to do well in mathematics.	SA	A	U	D	SD
71. I see mathematics as a subject I will rarely use in my daily life as an adult.	SA	A	U	D	SD
72. Winning a prize in mathematics would make me feel unpleasantly conspicuous.	SA	A	U	D	SD

YOU HAVE COMPLETED THE INSTRUMENT
THANK YOU

FORM B

	SA	A	U	D	SD
	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. I can get good grades in mathematics.	SA	A	U	D	SD
2. As long as I have passed, my mother hasn't cared how I have done in math.	SA	A	U	D	SD
3. It would make me happy to be recognized as an excellent student in mathematics.	SA	A	U	D	SD
4. I would have more faith in the answer for a math problem solved by a man than a woman.	SA	A	U	D	SD
5. My father thinks that mathematics is one of the most important subjects I have studied.	SA	A	U	D	SD
6. I see mathematics as a subject I will rarely use in my daily life as an adult.	SA	A	U	D	SD
7. My mother hates to do math.	SA	A	U	D	SD
8. I have a lot of self-confidence when it comes to math.	SA	A	U	D	SD
9. Winning a prize in mathematics would make me feel unpleasantly conspicuous.	SA	A	U	D	SD
10. Females are as good as males in geometry.	SA	A	U	D	SD
11. My father wouldn't encourage me to plan a career which involves math.	SA	A	U	D	SD
12. I study mathematics because I know how useful it is.	SA	A	U	D	SD
13. People would think I was some kind of grind if I got A's in math.	SA	A	U	D	SD
14. Studying mathematics is just as appropriate for women as for men.	SA	A	U	D	SD
15. My father hates to do math.	SA	A	U	D	SD

	SA	A	U	D	SD
	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
16. I will use mathematics in many ways as an adult.	SA	A	U	D	SD
17. My mother thinks advanced math is a waste of time for me.	SA	A	U	D	SD
18. Generally I have felt secure about attempting mathematics.	SA	A	U	D	SD
19. It's hard to believe a female could be a genius in mathematics.	SA	A	U	D	SD
20. My father has always been interested in my progress in mathematics.	SA	A	U	D	SD
21. Mathematics is of no relevance to my life.	SA	A	U	D	SD
22. I am sure I could do advanced work in mathematics.	SA	A	U	D	SD
23. If I had good grades in math, I would try to hide it.	SA	A	U	D	SD
24. My mother thinks I'm the kind of person who could do well in mathematics.	SA	A	U	D	SD
25. Mathematics will not be important to me in my life's work.	SA	A	U	D	SD
26. I'm no good at math.	SA	A	U	D	SD
27. My father has strongly encouraged me to do well in mathematics.	SA	A	U	D	SD
28. When a woman has to solve a math problem, it is feminine to ask a man for help.	SA	A	U	D	SD
29. My mother thinks I could be good in math.	SA	A	U	D	SD

	SA	A	U	D	SD
	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
30. I don't think I could do advanced mathematics.	SA	A	U	D	SD
31. Being regarded as smart in mathematics would be a great thing.	SA	A	U	D	SD
32. My mother wouldn't encourage me to plan a career which involves math.	SA	A	U	D	SD
33. I'd be proud to be the outstanding student in math.	SA	A	U	D	SD
34. As long as I have passed, my father hasn't cared how I have done in math.	SA	A	U	D	SD
35. I would trust a woman just as much as I would trust a man to figure out important calculations.	SA	A	U	D	SD
36. My mother has shown no interest in whether or not I take more math courses.	SA	A	U	D	SD
37. Knowing mathematics will help me earn a living.	SA	A	U	D	SD
38. I'm not the type to do well in math.	SA	A	U	D	SD
39. Girls can do just as well as boys in mathematics.	SA	A	U	D	SD
40. My father thinks advanced math is a waste of time for me.	SA	A	U	D	SD
41. I'd be happy to get top grades in mathematics.	SA	A	U	D	SD
42. Girls who enjoy studying math are a bit peculiar.	SA	A	U	D	SD
43. My mother has always been interested in my progress in mathematics.	SA	A	U	D	SD

	SA	A	U	D	SD
	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
44. Mathematics is for men; arithmetic is for women.	SA	A	U	D	SD
45. My mother has strongly encouraged me to do well in mathematics.	SA	A	U	D	SD
46. If I got the highest grade in math I'd prefer no one knew.	SA	A	U	D	SD
47. My father thinks I'll need mathematics for what I want to do after I graduate from college.	SA	A	U	D	SD
48. Math has been my worst subject.	SA	A	U	D	SD
49. Being first in a mathematics competition would make me pleased.	SA	A	U	D	SD
50. In terms of my adult life it is not important for me to do well in mathematics in college.	SA	A	U	D	SD
51. My mother thinks that mathematics is one of the most important subjects I have studied.	SA	A	U	D	SD
52. For some reason even though I study, math seems unusually hard for me.	SA	A	U	D	SD
53. It would be really great to win a prize in mathematics.	SA	A	U	D	SD
54. My father has shown no interest in whether or not I take more math courses.	SA	A	U	D	SD
55. Mathematics is a worthwhile and necessary subject.	SA	A	U	D	SD
56. My mother thinks I need to know just a minimum amount of math.	SA	A	U	D	SD
57. Males are not naturally better than females in mathematics.	SA	A	U	D	SD

	SA	A	U	D	SD
	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
58. I am sure that I can learn mathematics.	SA	A	U	D	SD
59. I would expect a woman mathematician to be a masculine type of person.	SA	A	U	D	SD
60. It would make people like me less if I were a really good math student.	SA	A	U	D	SD
61. My father thinks I'm the kind of person who could do well in mathematics.	SA	A	U	D	SD
62. I would expect to have little use for mathematics when I get out of school.	SA	A	U	D	SD
63. Women certainly are logical enough to do well in mathematics.	SA	A	U	D	SD
64. Most subjects I can handle O.K., but I have a knack for flubbing up math.	SA	A	U	D	SD
65. My mother thinks I'll need mathematics for what I want to do after I graduate from college.	SA	A	U	D	SD
66. My father thinks I need to know just a minimum amount of math.	SA	A	U	D	SD
67. I'll need a firm mastery of mathematics for my future work.	SA	A	U	D	SD
68. I don't like people to think I'm smart in math.	SA	A	U	D	SD
69. My father thinks I could be good in math.	SA	A	U	D	SD
70. I'll need mathematics for my future work.	SA	A	U	D	SD
71. Taking mathematics is a waste of time.	SA	A	U	D	SD
72. I think I could handle more difficult mathematics.	SA	A	U	D	SD

YOU HAVE COMPLETED THE INSTRUMENT
THANK YOU

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